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... CONTENTS ...

	Page
Status of General Science as Revealed Through State and City Courses of Study....*Clarence M. Pruitt*	367
Scales for Rating Pupils' Answers to Nine Types of Thought Questions in General Science.	
Type III.—Comparison .....*C. W. Odell*	382
Type IV.—Criticism .....*C. W. Odell*	387
An Experiment in the Development of Classroom Films..... *Dr. Thomas E. Finegan*	391
The Science of Common Things: XI. The Magic of Dame Nature's Mixing Bowl. *Joseph R. Lunt*	407
Dry-Ice .....*Howard W. Geisler*	413
The New Books	418
Science Articles in Current Periodicals	422
What to Make	426
Magazine List	428

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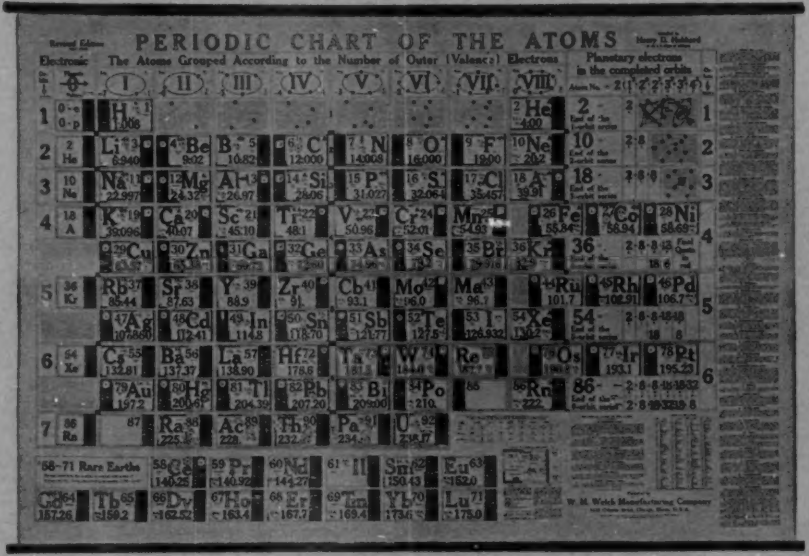

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Status of General Science as Revealed Through State and City Courses of State

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The status of general science as revealed through an examination of state and city courses of study, shows a situation that is very encouraging, yet at the same time indicates that there is much to be accomplished before general science has reached the standards and attained the recognition to which its adherents think it is entitled. Courses of study, especially state courses of study, still show a tendency to give it less attention than is given to the older subjects, such as English, History and Mathematics. One state course and a few city courses, ignore general science altogether. This seeming neglect is not unexpected, yet it is unusual. Although it has a definite place in the curriculum of most schools, it is looked upon with more or less disfavor by some school administrators and by some teachers of special science. The analysis reveals that the principles of organization, aims, methods of presentation, subject-matter content, and the desirable outcomes have not been as thoroughly established as in some of the older subjects. However, the newer courses of study and text-books reveal a core of content that is somewhat uniform and common to all. General science is no longer a grouping together of so much subject-matter content in physical geography, physiology, physics, botany, zoölogy and astronomy, as was true to a large degree in the beginning. It is now a real integrated course in science, with the emphasis on environment and deserving of the nomenclature *General Science.*

Courses of study, or suggested courses of study, of forty-two states were examined, in order to determine what recognition general science is receiving from the state departments of education. Some states issue separate courses of study in general science, while others issue combined courses. An attempt was made to answer the following questions:

Do the state departments require, recommend, or ignore general science?

In what grades is it offered?

Offered for one year, or more than one year?

How many periods per week?

Are aims or objectives stated?

Are textbooks and apparatus listed?

The following table gives a summary of the findings in the state courses of study. Blank spaces in the table indicate either that the information was unavailable or that the course of study ignored the particular item. A "Yes" in both the "required" and the "recommended" column means that general science was outlined as a required course in certain high schools (e. g., scientific course) or was an alternate requirement with some other science. It is probably true in a few cases that a state's "recommendation" is in actual practice a "requirement." This is true in those states in which acceptance of the state's recommendation is necessary in order that the school may appear on the state's "approved" list.

TABLE I. STATE COURSES OF STUDY.

STATE	Required	Recommended	7	8	9	Objectives Stated	Textbook or Reference	Apparatus
Alabama	Yes	Yes	Yes	Yes	Yes	Yes		
Arkansas		"			"	"		
California		"	"	"			Yes	
Colorado		"	"	"	"	"		
Connecticut		"	"	"	"			
Delaware	"	"			"	"	"	
Florida	"	"			"	"		
Georgia		"			"	"	"	Yes
Idaho		"			"		"	"
Illinois		"			"			
Indiana	(Ignored)							
Iowa		"	"	"	"	"	"	
Kansas		"	"	"	"		"	
Kentucky		"			"			
Louisiana		"	"	"	"		"	"

STATE	Required	Recommended	7	8	9	Objectives Stated	Textbook or References	Apparatus
	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Maine		"	"	"		"		
Massachusetts		"	"	"	"	"	"	"
Michigan		"			"	"	"	
Minnesota	"	"			"	"	"	
Missouri		"	"	"	"	"	"	"
Montana		"			"	"	"	"
Nebraska		"		"		"		"
Nevada		"		"		"	"	
New Hampshire		"	"	"	"	"	"	
New Jersey	"	"			"	"		
New Mexico		"			"	"	"	
New York		"	"	"	"	"		
North Carolina		"	"	"	"	"	"	"
North Dakota		"	"	"	"	"		"
Ohio		"	"	"	"	"	"	"
Oklahoma		"				"	"	"
Oregon	"	"	"		"	"	"	
Pennsylvania	"	"	"	"	"	"		
Tennessee		"			"			"
Texas	"	"		"	"	"		"
Utah		"	"	"	"	"	"	"
Vermont	"	"		"	"	"	"	
Virginia		"			"	"		"
Washington		"			"	"		"
West Virginia	"	"			"	"	"	"
Wisconsin	"	"			"	"		
Wyoming		"			"	"		"

TABLE I. SUMMARY.

42 State records were available.

11 Required General Science—at least for some students.

41 States recommended General Science.

1 of the 42 States ignored General Science.

22 Recommended General Science on the Junior High School level (exclusive of 9th grade level).

18 Recommended General Science in the 7th grade.

21 Recommended General Science in the 8th grade.

36 Recommended General Science in the 9th grade.

33 Stated some kind of objectives for the course.

22 Listed textbooks or reference books, or both.

17 Listed apparatus.

Only six states seem to definitely require a course in general science of all students. These six states are: Alabama, Oregon, Pennsylvania, Vermont, West Virginia and Wisconsin. With the exception of Wisconsin the course is required in the 7th and 8th grades. Wisconsin's requirement is an indirect one, but has the same effect as if it were an absolute requirement because "a curriculum approved by the state department must include one year of general science in the 9th or 10th year."

In actual practice it is probably often true that general science, when offered in high school, is open to any student in the high school (*e.g.*, Missouri and North Dakota) regardless of his grade classification. Usually courses recommending general science recommended a two-year course in the 7th and 8th grades of 3 periods per week, or a one-year course in the 9th grade of 5 periods per week. At least half of the courses stating objectives in general science listed the Seven Cardinal Principles. In several instances these were elaborated upon, but quite often they were not. Approximately half the courses list textbooks, references, and apparatus.

Almost without exception every city offering a course in general science had a syllabus which had usually been prepared by a committee of teachers. On the whole the status of general science is more clearly outlined in the cities than in the states. This fact is to be expected. State courses of study, reflecting more or less the educational conditions as regards educational thought and practice within the states, tend to lag behind the more progressive cities. The cities are the more progressive because they can devote more time and money to course of study construction, and because they have better-trained teachers, better science equipment and better facilities to put the course of study into operation. Over half of the cities studied have general science as a required course and in one-fourth of the cities it is a three-year course. It is probably true that in a majority of the cities which failed to mention whether general science was a required course or a recommended course, it is the former—at least for some students. It is also probably true that general science is a required course for certain groups of students in cities recommending general science.

TABLE II. CITY COURSES OF STUDY.

CITY	Required	Recommended	Year	Aims or Objectives Stated
Sacramento, Calif.	Yes	Yes	7-8-9	Yes
Los Angeles, Calif.	"	"	7-8-9	"
Oakland, Calif.	"		7-8-9	"
New York, N. Y.		"	7-8-9	"
Albany, N. Y.	"	"	7-8-9	"
San Francisco, Calif.	"		7-8-9	"
St. Louis, Mo.	"		7-8-9	"
Denver, Col.	"		7-8-9	"
Detroit, Mich.	"		7-8-9	"
Indianapolis, Ind.				Not offered
St. Paul, Minn.		"	9	Yes
Cleveland, Ohio	"	"	9	"
Washington, D. C.		"	7-8-9	"
Boston, Mass.	"		7-8-9	"
Great Falls, Mont.				Not offered
Clayton, Mo.		"	9	Yes
Ft. Madison, Iowa		"	9	"
Lansing, Mich.	"		8-9	"
Columbus, Ohio			8	"
Boulder, Colo.	"	"	7-8-9	"
Austin, Texas			8	"
Houston, Texas	"		6-7	"
Topeka, Kans.			8-9	"
Emporia, Kans.	"		8	"
Atlanta, Ga.			8	"
Kalamazoo, Mich.	"		7-8	
Everett, Wash.		"	9	
Bayonne, N. J.	"		8-9	"
Princeton, N. J.		"	7-8-9	"
Trenton, N. J.		"	9 ($\frac{1}{2}$ yr)	"
Champaign, Ill.			9	"
Akron, Ohio	"		8	
Springfield, Ohio	"		9	
Lakewood, Ohio	"		7-8-9	"
Kenosha, Wis.			8-9	"
Norfolk, Va.			7-8-9	"
Charleston, W. Va.			7-8	"
New Britain, Conn.	"		8-9	"
Hackensack, N. J.			8	"
Newton, Mass.	"		8-9	
Jamestown, N. Y.				"
Irvington, N. Y.			8	"

TABLE II. SUMMARY.

42 City courses were examined.

2 Cities do not offer general science.

21 Cities require it (at least of some students). It may be said that 40 cities recommend it or they would not have courses in it.

15 Cities have a three-year course 7-8-9 year.
1 City has a one-year course 6-7 year.
2 Cities have a two-year course 7-8 year.
4 Cities have a two-year course 8-9 year.
7 Cities have a one-year course 8 year.
7 Cities have a one-year course 9 year.
1 City has a half-year course 9 year.
35 Stated aims or objectives.

Practically all courses were offered in a sequence. Many of the city courses were quite detailed, which is not true of most state courses of study. Many of them listed apparatus, references and suggested problems.

There seems to be a tendency to place general science in the 7th and 8th grade and make it a required course. The newer courses of study (*e.g.*, St. Louis, Denver, Missouri and Colorado) indicate definitely that general science occupies a very important place in the junior high school curriculum (grades 7, 8 and 9) and that its aims and content have been fairly well established.

The data of Table III is from an analysis of the program of studies in seventy-eight junior high schools by Tryon, Smith and Rood. It is presented here for comparison.

TABLE III. SEVENTY-EIGHT JUNIOR HIGH SCHOOLS.

	7th Grade		8th Grade		9th Grade	
	Constant	Variable	Constant	Variable	Constant	Variable
Science:	22	3	45	11	28	42
1. Science	14	0	17	3	11	4
2. General science	8	1	23	7	10	29
3. Elementary science	0	0	5	0	0	0
4. Commercial science	0	0	1	0	0	0
5. Biology	0	0	0	0	7	6
6. Nature study	0	1	0	0	0	0
7. Physical geography	0	0	0	1	0	4
8. Botany	0	0	0	0	0	1

The analysis shows science or general science (probably same course) to be a constant or required course in twenty-two cities in the seventh grade, forty cities in the eighth grade, and twenty-one cities in the ninth grade. It is a variable subject

in one city in the seventh grade, in ten cities in the eighth grade, and in thirty-three cities in the ninth grade.[1]

The courses of study, especially state courses, reveal that the Cardinal Principles of Secondary Education (Bureau of Education Bulletin No. 35, 1918) and the Bulletin on the Reorganization of Science in Secondary Schools (Bureau of Education Bulletin No. 26, 1920) are having a marked influence on the statement of general science aims. Over half of the courses of study list the seven cardinal principles as aims. Some of these merely list the principles, while others make somewhat more elaborate statements.

The Oakland, California, course is one of the most detailed and comprehensive courses. A list of aims for the teacher and aims for the pupils are given for each half year of instruction, together with standards of attainment. Subject-matter material is indicated in some detail. Suggested problems, bibliography and references are included. The St. Louis and Denver courses are also quite detailed. Missouri has the most comprehensive state course of study.

For the purposes of determining the aims or objectives of general science, the following representative courses of study were analyzed: Denver, Los Angeles, Oakland, St. Louis; the States of New York, Missouri, Colorado, Texas, Maine, Virginia, Vermont; and Bayonne, New Jersey. Courses merely listing the seven cardinal principles were not included. A summary of the aims found in these courses of study is given below. This summary is included merely for what it may be worth. Someone else would probably state them slightly differently, but in the main the principles would be the same. No attempt was made to state them in order of importance.

SUMMARY OF AIMS

1. To develop powers and habits of diversified observation.
2. To give interesting information.
3. To develop scientific attitudes of mind.
4. To train pupils in accuracy of thought and expression in matters of science.
5. To lead pupils to interpret their environment.

---

1 "Program of Studies in Seventy-eight Junior High Schools," by R. M. Tryon, H. L. Smith and Allan F. Rood. School Review, Vol. XXXV (Feb. 1927), pp. 96-107.

6. To develop the ability to appreciate and apply the principles of personal and community hygiene.
7. To train pupils in problem solving.
8. To dispel belief in common superstitions.
9. To develop the ability to read intelligently popular scientific literature.
10. To give educational and vocational guidance.
11. To develop an appreciation of the great contributions of science to modern life.
12. To stimulate to further and more science study.
13. To develop in pupils the proper attitude toward science—civic problems and their solution.
14. To help pupils to understand better the common natural science phenomena and their applications.

In view of the fact that courses of study are unavailable to many teachers of general science and believing that a compilation of the aims of general science would be of some value, the following lists of aims have been included:

DENVER, COLORADO

1. To stimulate and direct children's natural curiosity about the common phenomena of their environment, to the end that they shall acquire a body of scientific information.
2. To develop powers of observation.
3. To stimulate a problem-solving attitude of mind.
4. To train pupils in accuracy of thought and expression.
5. To lead pupils to make interpretive judgments on the basis of observed facts.
6. To arouse an intelligent concern relative to questions of public health and sanitation.
7. To develop an appreciation for the great contributions of science to modern life.
8. To lead children to read with enjoyment, scientific books and periodicals.
9. To dispel belief in common superstitions, signs and charms.
10. To stimulate to further and more scientific study.

The Denver course also has objectives worked out for each unit. Those for Weather and Climate (Grade 7B) are reproduced for illustration.

1. Knowledge of the factors of weather and their operation.
2. Realization that weather is not haphazard, but is subject to scientific laws.
3. Application for the work and service of the U. S. Weather Bureau.
4. Understanding of the importance of climate in human affairs.

ST. LOUIS, MISSOURI

1. To appreciate more fully and to enjoy simple natural phenomena most common in one's life.
2. To gain knowledge of processes and appliances which will enable one to perform more intelligently unspecialized practical activities for the well-being of the home and community.
3. To acquire ability to use knowledge already gained toward the solution of new-problems as a beginning of scientific thinking.
4. To acquire confidence and belief in the knowledge gained by the use of the scientific method to the extent that it will influence daily conduct through the formation of good habits.
5. To acquire a disposition to participate actively in the consideration of the solution of community problems which involve scientific knowledge.
6. To know somewhat definitely where to find information regarding scientific facts and what general application the several sciences have in the world.
7. To acquire the ability to decide more thoughtfully, through the organization of common experiences and from extensive reading, the advisability of more intensive efforts along scientific lines.

LOS ANGELES, CALIFORNIA

1. The ability to read intelligently popular scientific literature such as the layman is likely to read and to discriminate between the scientific and pseudo-scientific.
2. Ability to appreciate and apply the principles of good health, such as balanced rations, adequate clothing, cleanliness, sanitation, ventilation.

3. Ability to understand the principles governing the simple scientific facts with which man comes in contact.
4. The ability, disposition, and habit of diversified observation of natural phenomena, such as erosion, weather, etc.
5. Ability to understand how common appliances and machines work—such as a watch, a flashlight, a washing-machine, electric devices, an automobile.
6. Ability to think in matters of science in a logical manner —that is, reasoning from cause to effect.
7. Ability to learn facts of science from lectures, pictures, museums and exhibits.
8. The ability to maintain an active interest in some branch of science so that it may serve as the incentive to a vocation or a career.
9. Ability to care intelligently for the plants and animals about the home.
10. Ability to recognize scientific civic problems, and to cooperate in their solution, such as sewer and water problems, milk supply, etc.
11. Ability to recognize the importance from a scientific viewpoint of the questions relating to conservation of national resources, such as preservation of national forests, care of public parks, forestry etc.
12. Ability to realize that life and all its physical activities are governed by a few basic scientific principles.

NEW YORK STATE COURSE

1. To increase the pupil's appreciation and awareness of the factors of his environment.
2. To develop the pupil's powers of observation through a carefully directed study of the common phenomena of his immediate environment.
3. To give the pupil training in the use of the scientific method in solving problems.
4. To stimulate the pupil so to organize his common experiences that he shall make a more direct and purposeful use of his activities and to provide him opportunities for practice in applying the knowledge already gained to the solution of new problems.

5. To foster in the pupil a confidence and belief in the knowledge he gains by the use of the scientific method to the extent that it will influence his daily conduct through the formation of good habits.
6. To develop the pupil's practical knowledge of personal and community hygiene and his will to practice the one and to co-operate in maintaining and improving the other.
7. To give the pupil a working knowledge of some of the specific ways in which the facts, principles, and laws of his environment are related to and used in the world's work in order that he may more fully appreciate the vital place of science in the community and its bearing upon national progress.

VERMONT STATE COURSE

1. To give the pupil an opportunity to discover whether he has sufficient aptitude for science to make further science courses desirable is an approach to a vocation.
2. To vitalize subject-matter and motivate study through a presentation of practical problems, coördinating other branches of first and second year study.
3. To hold the pupil's interest in school at a time when he is most likely to lose it, by showing him some of the wonders of everyday life.
4. To summarize the science of the grade schools and provide a basis for the science work which follows.
5. To train the pupils to observe carefully, reason clearly, and express themselves definitely.
6. To put the pupils in sympathy with their environment.

MISSOURI STATE COURSE

1. To help pupils in becoming better acquainted with the natural science factors in their daily lives.
2. To help pupils to understand better the common natural science phenomena and their applications.
3. To help pupils to build up more efficient controls of environmental factors.
4. To aid pupils in developing intelligent interests in natural phenomena, social and industrial applications of scientific principles, and in the work of research investigators.
5. To help pupils in forming habits of reading intelligently the literature of science and current descriptions of scientific work.

6. To help pupils in developing the ability to solve natural science problems themselves.

MINNESOTA STATE COURSE

1. Health and sanitation should be applied to the individual and the community to learn how to preserve health, thereby adding to contentment and usefulness. All teaching effort directed toward these goals elevates the manhood and womanhood of our nation.
2. Good citizenship should be taught through an understanding and appreciation of natural laws and their scientific application to civic problems. The importance of the citizenship objective is made clear from the application of science to enterprises under civic control, such as purification of water, efficient consumption of fuel, ventilation of public buildings, care of foods, cold storage.
3. The scientific method should be used for problem solving. This method of attack teaches the individuals what constitutes definite proof, the sequence of cause and effect, and ability to organize through induction.
4. General science contributes to educational and vocational guidance by providing a rich exposure to scientific phenomena with reference to specialized fields.
5. A considerable portion of the content of general science has no other immediate objective than that it satisfies interest and curiosity. The normal mind naturally seeks explanations of observed phenomena, often for no other reason than the instructive desire to know.

MAINE STATE COURSE

1. The development of interests, habits and abilities.
2. Teaching useful methods of solving problems.
3. Good science teaching should stimulate the pupil to more direct and purposeful activities.
4. Science study should give the pupil control of a large body of facts and principles of significance in the home, school and community.
5. Science study develops appreciation of the contributions of science to man, of the service of its revelations in natural life.

TEXAS STATE COURSE

1. The student should obtain a sufficient knowledge of the working of the usual industries to be able to decide intelligently questions arising before him as a citizen concerning them.
2. The student should obtain a sufficiently broad knowledge of the interrelation of science and industry to appreciate the necessity of a scientific training, and to decide what course to pursue in high school.
3. The usual training given by all sciences should begin here, such as the power of observation, habit of basing his conclusions on observations, facility of manipulation, etc.

COLORADO STATE COURSE

1. To prepare a student for a more intelligent citizenship through a better understanding of the scientific phenomena related to his daily experiences. In order to accomplish the aim of intelligent citizenship the student will need to acquire a fund of knowledge about common things; a habit of thinking accurately in terms of his surroundings; an honest scientific attitude which will allow him to face without prejudice any phenomena or data.

VIRGINIA STATE COURSE

1. It is the connecting link between the nature study and geography of the grades and the laboratory instruction in the pure sciences of the high school.
2. It is an introduction to the study of the more advanced courses, and in this capacity aids pupils in the choice of a vocation where science is involved.
3. It furnishes an insight into the value of science in coping with the daily affairs of life for that large body of pupils that leave high school at the end of the first year.

BAYONNE, NEW JERSEY

1. To explain for pupils natural phenomena that have interest and significance for them, and to impart such additional knowledge as their interests and needs demand.
2. To encourage pupils to solve simpler problems as a beginning of scientific thinking.
3. To develop such easily comprehended principles as apply to local environment and pupils' interests.

4. For culture.
5. Training in important habits as observation, neatness, accuracy, etc.
6. Mastery of underlying principles preparatory to later science work.
7. To show the importance of science in the development of the industrial and social life of the community.

Several summaries of aims have been previously reported.[2] Two more recent summaries of aims, each reported independently, are appended for comparison.

A. SUMMARY OF AIMS FROM 169 SOURCES.[3]

		Frequency of mention
1.	Choice of and efficiency in a vocation	114
2.	Health	111
3.	To understand one's environment	93
4.	A knowledge of life's activities	92
5.	Good citizenship	73
6.	Ethical character	35
7.	Worthy home membership	28
8.	Wise use of leisure time	28
9.	Skill in scientific method	8
10.	Habits	6
11.	Ideals	6
12.	Development of interests, attitudes, capacities	4
13.	Development of skill in using materials	4
14.	To train judgment	3
15.	To develop constructive imagination	3
16.	Tastes	3
17.	To cultivate perceptive faculties	2
18.	To prepare for other subjects	2
19.	Command of fundamental processes	1
20.	Acquaint pupils with scientific terminology	1
21.	Encourage inquiry	1
22.	Teach conservation of natural resources	1
23.	Teach dependence of industry on science	1

2 (a) Ralph Knupl. Watkins, "The Technique and Value of Project Teaching in General Science," in General Science Quarterly (May and November, 1923, and January, 1924), Vol. VII, pp. 235-256 and Vol. VIII, pp. 311-341 and 387-422.

(b) Philipine Crecelius, "A Report on Objectives of General Science," in School Science and Mathematics (April, 1923), Vol. XXIII, pp. 313-319.

(c) Ada L. Weckel, "Are Any Principles of Organization of General Science Evidenced by Text-book Writers in the Subject." Investigations in the Teaching of Science, F. D. Curtis, P. Blakiston's Son and Co., Philadelphia, pp. 198-204.

(d) C. M. Howe, "Average Rank of Certain Aims of the Course in General Science as Evaluated by Eighty Teachers of the Subject." The American Secondary School, by Leonard V. Koos, Ginn and Co., pp. 418-420.

3 From the Fifth Yearbook, Department of Superintendence, National Educational Association, p. 149.

B. SUMMARY OF SCIENCE OBJECTIVES IN STATE AND CITY COURSES OF STUDY.[4]

	SCIENCE OBJECTIVES	Frequency of mention
1.	To help pupil to interpret his environment	12
2.	Citizenship	8
3.	Supply fund of interesting information	7
4.	Help pupils to become better acquainted with natural science factors in environment	6
5.	To encourage pupils to form accurate habits of observation and expression	6
6.	To awaken science interest and ability, that scientific interests may be continued	6
7.	Technique of experimentation	6
8.	Train in scientific methods for problem-solving	6
9.	Help pupils understand natural science phenomena and applications	5
10.	To instill scientific attitudes	5
11.	To reveal strictly scientific vocations	5
12.	Health	4
13.	To provide "hobbies" for leisure time	4
14.	To give beginners a general knowledge of the field	4
15.	Vocational training	4
16.	Worthy home membership	4
17.	Ability to think clearly and accurately about scientific material	3
18.	Co-operation	3
19.	Inculcation of scientific spirit	3
20.	Interrelation of sciences	3
21.	Preparation to meet college requirements	3
22.	Use of leisure time	3
23.	Appreciation of natural and moral laws	2
24.	Discover appreciation for domesticated varieties of experience and desire to co-operate in their improvement	2
25.	Ethical character	2
26.	Help pupils read intelligently the literature of current science publications	2
27.	Interest in betterment of human conditions and human race	2
28.	To create an interest in lives and works of great scientists of the past	2
29.	To bring about an idea of the vastness and grandeur of the universe	2
30.	To stimulate scientifically inclined; a desire to accomplish something worth while in scientific field	2

4 Carter V. Good, "The Mathematics and Science Curricula in Junior and Senior High Schools." School Science and Mathematics, XXVII, No. 8 (November, 1927), pp. 863-69.

Scales for Rating Pupil's Answers to Nine Types of Thought Questions in General Science[1]

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TYPE III.—COMPARISON

Compare surface water with deep well water for house drinking purposes,

Value 0

Pupil Answer. The well water comes from under ground therefore gems can get into the water and poison it; while the surface water comes from lakes it is purlized and is fit for drinking and for house use.

Criticism. No knowledge is shown of the question. A reversal of meanings of the sentences makes the paper meaningless.

Value 1

Pupil Answer. Deep well water is best because it has been purified more than the other.

Criticism. Some knowledge is shown of the subject in the statement that well water is best because it has been purified. This answer does not state that surface water is liable to be dirty. In fact, there is no comparison made, because surface water is not mentioned.

Value 2

Pupil Answer. Surface water is not good for drinking purposes because it is not pure. In summer people often go swimming which causes the water to become dirty.

Deep well water is used for the house because the water is soft. This water is also used for drinking purposes, because the people who live in the country have no other ways to get water.

While surface water is impure, deep well water is pure because it came directly out of the ground.

Criticism. This paper states definitely that deep well water is pure, and that surface water tends to be impure, whereas Number 1 does not speak of surface water at all. No mention is made of the presence of germs in surface water and no reason is stated why well water is pure. A false statement is made that deep well water is soft.

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1 Continued from Vol. 12, No. 1, Nov. 1927. The author will be very glad to receive criticisms or suggestions regarding these scales.

VALUE 3

Pupil Answer. Surface water is usually not fit to drink because it full of germs and full of decaying matter. And for household use it is very hard and soap will not mix well with it.

Deep well water is usually fit to drink as it is not polluted by drains and sewage disposals. Deep well water is usually soft and can be used for household purposes.

Criticism. The statement is made that surface water usually is not fit to drink because of germs and decaying matter, while Number 2 merely states that surface water is impure. The fact is not stated that filth and germs cannot be as easily washed into deep wells as into shallow ones. The facts regarding the softness or hardness of well and surface water have been reversed in this paper.

VALUE 4

Pupil Answer. Surface water should not be used for house drinking purposes because it may contain desease germs and therefore be impure, filth and bacteria may drain into this water and it should not be used. Deep well water should always be used as it is more safe. Filth and germs cannot be washed into these weils as easily as shallow ones. The shallow wells may sometimes contain desolved minerals which would be harmful.

Criticicm. This answer states that filth and germs cannot be washed into deep wells as easily as into shallow ones. Number 4 gives a more complete comparison of the value of surface and deep well water for drinking purposes than does Number 3. The coolness of well water, the filtration of well water by the soil, and the fact that dead leaves, loose matter and poisonous insects may make surface water unfit to drink, are omitted.

VALUE 5

Pupil Answer. Well water is better for drinking purposes than surface water. Well water is cold and is filtered by the soil while surface water must be artificially filtered and a chemical mixed with it. On the surface dead leaves, loose matter, or poisonous insects may come in contact with the water. Well water is free from all this.

Criticism. Well water is described as being cool and filtered. Dead leaves, loose matter, or poisonous insects are spoken of as causing surface water to become unfit for drinking purposes. No mention is made of the fact that well water is

better for drinking purposes because it is freer from germs and refuse. "Loose matter" needs further definition.

VALUE 6

Pupil Answer. Surface water is not as good as well for house and drinking purposes. Surface water gathers up much refuse and germs as it flows. Well water is water that was surface water but was filtered as it sunk in the soil. It then comes up as well water. It is therefore better for house and drinking purposes because it is free from refuse and germs.

Criticism. This answer speaks of the possible germ content of surface water and mentions that deep well water is better for drinking because it is free from refuse and germs (possibly not entirely true). The explanation given in Number 6 is not as complete as in Number 7. No mention is made of the barnyard as endangering surface water. The impression is given that surface water consists only of that water flowing along the top of the ground. The fact that surface water becomes stagnant while deep well water does not, is not brought out.

VALUE 7

Pupil Answer. Surface water is not as pure as the deep well water is, because it is out in the open, and any kind of a disease germ may settle in it. The surface water may flow from a dirty place such as a barn yard, which contains many different kinds of germs. The deep well water is purified as it runs down in the earth, for it runs through gravel, rocks, sand and other materials which helps to purify the water. The deep well water always runs, more clean water comes in, therefore it does not become stale as the surface water does.

Surface water is not sanitary compared with the deep well water.

Criticism. The barnyard is spoken of as endangering surface water. It is shown that deep well water is filtered by the water passing through gravel, rocks, sand, and so forth, and that deep well water will not become stagnant since it is a deep underground stream. The last sentence is a better summary statement than is found in Number 6. This paper does not speak of the danger of organic matter in surface water; of the fact that surface water is more easily contaminated since water is the universal solvent; nor of the mineral matter in deep well water. No attempt is made to define good drinking water.

VALUE 8.

Pupil Answer. Water for house drinking purposes must be reasonably pure; that is, it should contain nothing that will injure the system when taken internally.

Good drinking water should be colorless and odorless, with the taste pleasant but not too pronounced. Any odor, color, or strong taste indicates the presence of some substance that might be harmful to the body.

Since water is a universal solvent it is likely to become contaminated by some decaying animal or vegetable matter with which it comes in contact. Surface waters usually contain organic matter in solution, and although many organic substances are harmless, others are dangerous to health and to life.

Deep well water contains little organic matter because it is removed as the water filters throught the earth's crust. During this process of filtration, an abundance of mineral matter may dissolve in the water and render it unfit for drinking purposes. However, water from deep wells is usually pure, and the mineral salts when present in the right proportions have certain medicinal values.

Criticism. A good attempt is made to describe "good drinking water." The writer brings out that surface water is easily contaminated since water is the "universal solvent," and that many organic substances are dangerous to health and life. In discussing results of drinking contaminated water, no mention is made of germs nor of the sources of the dangerous matter in surface water. No discussion is included in Specimen 8 of the possibility of communicating stomach and bowel diseases, such as typhoid fever, through drinking surface water. The second sentence in the second paragraph may not always be true.

VALUE 9

Pupil Answer. Deep well water is far preferable to surface water for house drinking purposes. Surface water carries animal and vegetable matter obtained from three principal sources, wastes from human beings and animals, decaying plants and animals, and garbage. The first name is most dangerous because of the possible presence therein of germs causing such diseases as: typhoid fever, cholera, dysentery, enteritis, and diarrhea. More than three fourths of all cases of typhoid fever in the United States and many of the stomach

and bowel troubles are traceable to contaminated drinking water. After surface water has seeped through one hundred or more feet of close packed soil or an additional distance through more porous material, the harmful bacteria are all filtered out, provided the soil has not become clogged with an excess of the residue. While such water may contain compounds of sodium, calcium, magnesium, iron, sulphur and other elements, it is harmless from a bacterial standpoint and may be beneficial because of the mineral content.

Thus, while surface water may be a source of grave danger if used for house drinking purposes, deep well water, when obtained not less than one hundred feet distant from any source of pollution and protected from surface water, is quite safe.

Criticism. The statement is made that germs may be found in surface water and the three principal sources of contamination are given. Typhoid fever, cholera, diarrhea, and other stomach and bowel diseases are mentioned as results of drinking surface water contaminated by human and animal waste matters. A discussion is given of the removal of bacteria through soil filtration and the possibility of the soil being clogged with an excess of the residue. As to comparing surface water with deep well water for drinking purposes, Number 9 gives a less direct and concise comparison of surface water with deep well water than does Number 10. No mention is made of the fact that, on the average, there is greater danger in villages and small towns.

VALUE 10

Pupil Answer. Surface waters from rains or melted snows flow into cisterns. On farms the surface water is contaminated with barnyard refuse, made up largely of plant and animal waste. In villages and small towns such waters are polluted with street dirt, backyard refuse, and filth of every sort. Seepage from cess pools and stables is another source of contamination. Sewage, which often filters into surface water, is a source of dangerous disease.

The deep well water is usually found to be safer for house drinking purposes. After filtering through many feet of soil, there is little chance of its containing disease germs or waste and dirt. Its taste is more agreeable to most people because of its mineral content. Deep well water is apt to be cooler

and of a more nearly equal temperature in summer and in winter.

Criticism. This is a good discussion of practically all the important points of the question. Mention is made of the more agreeable taste and greater coolness of deep well water. Number 10 is a more direct, concise comparison of surface water with deep well water for house drinking purposes than Number 9. Mention is made of greater danger from surface water in villages and small towns.

TYPE IV.—CRITICISM

Criticise: "Bacteria cause many diseases among men, therefore they should be destroyed."

VALUE 0

Pupil Answer. Bacteria cause many diseases. They cause pneumonia, scarlet fever, appendicitis, tonsilitis and many others.

Criticism. This answer speaks merely of the bad effects of bacteria; but gives no criticism of the topic. Little knowledge of the subject is shown. Appendicitis is not usually considered a germ disease.

VALUE 1

Pupil Answer. There are two different kinds of bacteria one of which does harm and the other good.

Criticism. An indefinite statement is made that one kind of bacteria is harmful and another kind helpful. It does not state that some bacteria are necessary to life.

VALUE 2

Pupil Answer. Some Bacteria are necessary to life, so all should not be destroyed.

Criticism. This answer merely gives a general reason why all bacteria should not be destroyed—some are necessary to life. The paper is very incomplete and makes no differentiation between good and harmful bacteria.

VALUE 3

Pupil Answer. I think bacteria should not be destroyed. Because we could not get along with out some bacteria. It would be all right just to have the good bacteria, but not have the harmful.

Criticism. The thought is expressed that it would be all right to have good bacteria, but that harmful bacteria should

be destroyed. It is shown much more definitely than in Number 2 that some bacteria are good and others harmful. The points included in Number 4 that disease germs are harmful and decay germs are useful are omitted.

VALUE 4

Pupil Answer. There are many bacteria that cause disease but there are also many kinds of bacteria that men could not do with out them, as the bacteria of decay, etc.

Criticism. Bacteria are mentioned as harmful in causing disease and as useful in causing decay. The use of bacteria in souring milk and making cheese is not included. This paper presents a little criticism and is less complete and definite than Specimen 5 in telling how bacteria are helpful to man.

VALUE 5

Pupil Answer. The bacteria should not be destroyed, because if it was the milk would not sour or you couldn't make cheese or several other things which are helped made by bacteria.

One Kind of Bacteria makes a man sick and another kind help to make them well, therefore the bacteria should not be destroyed.

Criticism. This paper speaks of the helpfulness of bacteria in souring milk and making cheese. It is more complete and definite than Number 4 in telling how bacteria are helpful to man. No mention is made of the service of bacteria in causing decay of vegetable and animal matter which fertilizes the soil. The last sentence is weak and does not clearly point out that harmful bacteria should be destroyed and helpful bacteria should be preserved.

VALUE 6

Pupil Answer. In one way the bacteria should be destroyed. There are harmful bacteria that should be exterminated. But, if all bacteria should be destroyed, man could not live. In fact, there would be no living matter on earth. Just one instance shows how necessary bacteria are, they decay the vegetable matter and animal matter that make the ground fertile. If there were not this, no crops could be grown.

Criticism. The statement is made that the life of man is dependent on bacteria and the necessity is shown for the action of bacteria in causing decay of vegetable and animal matter with which the soil is enriched. The first sentence states that some bacteria should be destroyed while the first sentence in

Specimen 5 says that bacteria should not be destroyed. The differentiation between harmful and helpful bacteria is not made as clearly as in Number 7. There is little criticism of the statement.

VALUE 7

Pupil Answer. The statement above the first half of it is true. Bacteria does cause many diseases among men. But looking at the other part one can not readily agree, knowing that bacteria is as important and useful as it is harmful.

It causes many serious diseases:

(a) Lung Trouble.

(b) Diphtheria.

(c) Scarlet fever. Etc.

It helps in many ways one of which is:

(a) It is used to flavor things.

(1) as cheese. Cheese is thought bad sometimes simply because bacteria is missing.

Criticism. A clear differentiation is made between harmful and helpful bacteria, and illustrations are given of each type. The good and bad effects produced by bacteria are given more definitely than in Number 6. This answer does not mention the souring of cream, or the making of vinegar and yeast, as the result of the action of bacteria. Little criticism is made of the topic, and little evidence is presented as to why all bacteria should not be destroyed. The harmful effects of bacteria are given most emphasis.

VALUE 8

Pupil Answer. All bacteria are not harmful, some bacteria are very useful as those which make vinegar, sour cream, yeast. It is true there are some harmful bacteria, but there are as many bacteria which are of use to us, as those which are harmful. If we keep our bodies in good health, we will not take diseases from the bacteria found floating in air. Therefore I think that the useful bacteria are more helpful, and more than overcome the harm done by the bacteria which causes diseases.

Criticism. Good points are brought out in connection with the usefulness of bacteria in souring cream and making vinegar, yeast, and cheese. This paper presents a better discussion than Specimen 7 in that it gives more evidence why all bacteria should not be destroyed. Nitrogen-fixing bacteria are not mentioned, and no statement is included that helpful bacteria should be preserved and harmful bacteria destroyed.

VALUE 9

Pupil Answer. The sentence above is not true to a certain extent because there are two classes of bacteria, one that either helps men or destroys and fights against men.

The bacteria that help men are a great help to man in his life. There are the soil bacteria which take the dead plants and animals and changes them to humus. Humus enrichs the soil very much furnishing some products that essential to plant life. There are also the nitrogen-fixing-bacteria which take the nitrogen from the air thru a certain process and store it up in the soil, where it becomes mixed with water in the soil and makes the plant grow. There are also the bacteria which help to make cheese, etc.

It is true that many bacteria cause diseases among man that should be destroyed, before they become in so large numbers that they will wipe many people.

Criticism. A good discussion is given of nitrogen-fixing bacteria. A statement is made that bacteria harmful to man, but not all bacteria, should be destroyed. No mention is made of the ripening of milk and butter or of various fermentations.

VALUE 10

Pupil Answer. The statement is partially untrue, because it gives no attention to the case "for" the bacteria.

Though some bacteria are responsible for many diseases among men, animals, and plants, others affect our lives in quite different ways. Economically they are very important. Together with the fungi they are the chief cause of decay, thus helping to keep the surface of the earth clean. Bacteria ripen milk and butter and are necessary in cheese making and various fermentations. Those bacteria that fix nitrogen are very valuable in agriculture.

Therefore, the sweeping statement above is not correct, since we should wish to destroy only the harmful bacteria and not the many useful ones.

Criticism. This answer discusses in a clear and concise manner practically all the important points. The economic value of bacteria is mentioned in connection with the ripening of milk and butter, making cheese, fixing nitrogen, causing decay, and fermentations.

An Experiment in the Development of Classroom Films[1]

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There are three chief reasons why motion pictures have not come into general use as an agency in classroom instruction. These are:

1. Few motion pictures adapted to classroom service have been produced.

2. The cost of the necessary equipment and the cost of production and distribution have rendered motion pictures prohibitive for classroom service.

3. Teachers generally are unfamiliar with the use of motion-picture apparatus and with the use of film, and there is more or less feeling on their part that some embarrassment might follow an attempt to use them.

The production of a type of film suitable for classroom use is purely an educational or professional problem. The cost of producing the necessary equipment and the cost of making and distributing films is purely an economic or business question. The training of teachers to use and to appreciate the value of films is a simple question of good school administration.

The general use, therefore, of classroom films resolves itself into the solution of these questions. Is it possible to produce the character of films which will yield measurable results in classroom work of sufficient value to make their use a profitable investment? If such films can be produced and this result can be achieved, is it possible to produce them at a cost which will make it practical and feasible for the schools to provide them? May teachers be trained to use motion-picture apparatus and to evaluate film service?

It may not be expected that motion pictures will be given popular recognition as a teaching agency by educational authorities until sufficient reliable data upon these vital questions are made available. A few experiments in this field have been conducted in this country and in Europe, but the extent and the general scope of such experiments have been wholly inade-

1 Address delivered before the Society of Motion Picture Engineers, Lake Placid, N. Y., September 28, 1927.

quate in the results recorded and in making available to the public material upon which a basis for the determination of these questions may be reached.

The experiment under consideration was not entered upon in the belief that it would afford all the information desirable in the development of a sound program of visual instruction through the use of motion pictures. It was undertaken in the belief that it would reveal the essential fundamental knowledge for the solution of the chief questions which we have stated are the basis of the development of such program.

A brief statement of the movement which led to the experiment will give a better understanding of its purpose. In 1922 the National Education Association created a committee on Visual Education, to develop plans which would extend the use of visual aids in the schools. This committee established co-operative relations with the Motion Picture Producers and Distributors of America, Inc. The purpose of the committee was brought to the attention of the Eastman Kodak Company.

In March, 1926, Mr. George Eastman announced that the Eastman Kodak Company had made a survey which showed in substance that little had been accomplished in the production of suitable films for classroom service; that there appeared little prospect that an organization with sufficient resources would enter upon a program to produce films of this type on an adequate scale; that motion pictures for this specific purpose were not practicable until an easily operated projector and economical films were available, but that he believed projectors on the market and the narrow width films would afford a solution of the economic aspects of this problem.

This announcement further stated that, in view of these conditions, and after full deliberation, the Eastman Kodak Company had decided to approach the solution of this problem by an experimental method; that under the advice and co-operation of leading teachers the company would produce a number of classroom films closely correlated with selected courses of study and in accordance with a definite educational plan; that provision would be made to give these films adequate trial in classroom practice to determine their value for such use; and that through the results achieved it should be possible to reach sound conclusions on the effectiveness of films as a classroom

aid, and also to ascertain the probability of producing such films at a cost which would make them available for popular classroom service.

Following this announcement Mr. Eastman invited several leading teachers and school administrators from various parts of the country to Rochester for a conference at which he presented the general plan of the proposed experiment. The conference gave cordial approval to the plan. It also expressed an unanimous opinion that in the experimental stages of working out a program it was essential to concentrate upon the most vital subjects of the fourth, fifth and sixth grades and the junior high school.

The general features of the proposed experiment were included in the Report of the Committee on Visual Education of the National Education Association at its annual meeting in June, 1926, and the general assembly of that body, by unanimous vote, expressed the opinion that an experiment of this character would render invaluable service to the educational interests of the nation and recommended that teachers and school officers throughout the country extend every possible assistance and co-operation in this experiment.

The experiment described in this paper, therefore, is the one now being conducted by the Eastman Kodak Company in co-operation with the schools of several cities of the country in the development and use of classroom films. The work of organizing the material and the planning of the experiment began in September, 1926.

There were certain lines of procedure in relation to motion pictures and to schoolroom practice which had to be cleared up before entering upon the real work of this experiment. For instance, in dealing with subjects intended to develop correct attitudes and habits in life, on the part of children, as in courses relating to health, we have followed the procedure of basing films on the positive or constructive practices which show the benefits derived from pursuing such courses, instead of basing the films on the negative or improper practices and the penalties resulting therefrom.

There are also certain scenes entirely proper from the ethical viewpoint, which would shock or intimidate children of sensitive nervous systems. Therefore, all scenes which might

produce undesirable mental reactions on the part of children have been avoided in preparing Eastman Classroom Films; as for instance, a scene in the film on Cattle which shows the branding process, scenes containing repulsive practices, etc.

Motion pictures have been so universally used since their beginning as a means of entertainment that in the great majority of attempts to adapt them to the use of schools the entertainment idea has been carried over in them. The story and the drama are factors of great power in educational processes and especially with children of the lower grades. Where this form of instruction is resorted to, it should be presented by the masters in story-telling and in the dramatic field. But all the work of the schools should not be administered upon entertainment or dramatic lines.

Films should not be made primarily to entertain children or to exert a dramatic power over them. They should be made with the intent to present accurate viewpoints and pictures of actual conditions representative of our social and economic life. The dominant tone and spirit of the film should be to present ideas, to reveal processes, to clarify situations, to represent actualities—to instruct.

Motion pictures should be what the term implies, and that is pictures which represent motion or action. These pictures should deal with situations, activities, operations, processes, etc. With these restrictions in their use there is an inexhaustible field of service for the motion picture. The subject selected for filming should fall within these limitations. Certain subjects may be represented as well and even better by still pictures than by motion pictures. A program of motion pictures should not invade the still picture field. In the activities and processes of every avenue of human effort and interest are subjects of vital relation to society which can be accurately represented by the motion picture only. In developing films to be used in the Eastman experiment the limitations herein prescribed for motion pictures have been respected.

This experiment is designated as one in the development of classroom films. What are classroom films, and how do they differ from other films? The name itself denotes a special and definite use, and therefore a distinct type of film. The name implies a film used in the classroom by a teacher giving instruc-

tion to his pupils. This type of film is therefore simply a classroom agency in the hands of the teachers. It is to be used by him when needed, similarly to the use of other classroom aids or apparatus. It is not a substitute for the teacher nor for the text-book. It is just a tool to clarify his work and make it more impressive. It should be adapted to specific lessons and to definite grades.

The classroom film should be distinguished from the general assembly or auditorium film. The auditorium film is one intended to be used for a general audience of varying ages, grades and interests. It is used to provide entertainment or to give mass instruction. There is no competition between these two types of films; one does not serve the legitimate function of the other. A film which is developed on pedagogical lines to illustrate a fundamental principle or to clinch some central truth which the teacher is endeavoring to develop in the minds, for instance, of a class of sixth grade pupils, is seldom adapted to the use of the general assembly. On the other hand, a film which will provide instruction or entertainment for the auditorium is not generally adapted to the more limited and specific purposes of the classroom.

Briefly, the plan of the experiment is as follows: The school authorities in twelve cities of the country were invited to cooperate in the experiment. To give the experiment the benefit of varied interests and viewpoints in education and to make it expressive of national interests and conditions, cities were selected from various sections of the country. The following cities were chosen:

1. Newton, Mass.
2. Rochester, N. Y.
3. Detroit, Mich.
4. Chicago, Ill.
5. Lincoln, Neb.
6. Denver, Colo.
7. Oakland, Calif.
8. San Diego, Calif.
9. Kansas City, Mo.
10. Atlanta, Ga.
11. Winston-Salem, N. C.
12. New York, N. Y.

Four schools have been designated in each city for experimental work. Three of these are elementary schools and one is a junior high school. Two groups of children will be under instruction,—the control group, or those given instruction without the use of films; and the experimental group, or those given instruction with the use of films. Each of these groups will

represent children coming from similar home environments and social conditions in life. They will be given tests to determine that they are on the same intellectual level. In each city there will be at least 320 pupils receiving instruction in the same area of the subjects included in the experiment. There will be 160 receiving instruction with the use of the films and 160 without the films.

In six of the cities it has been planned to use 1,000 pupils in classes instructed with the use of films, and 1,000 in classes without the use of films. In each of these six centers 2,000 pupils will be included in the experiment. It is believed that an experiment of this character, with approximately 14,000 pupils in twelve leading cities in the various parts of the country, will be adequate to obtain reliable and convincing evidence on the problems involved in this experiment.

Three subjects in the school curriculum have been chosen, and films are being produced on topics outlined in the curriculum for classroom consideration. These subjects are geography, general science, and health.

In geography thirty films will be produced. They will be limited to the United States and will, of course, be correlated with the subjects as treated in the curriculum. They will be adapted to children of the fifth and sixth grades. In general science fifteen films, and in health five films are being produced. These films will be adapted to the pupils of the first and second year of the junior high school, and will be correlated with the selected subjects treated in the curriculum.

It has already been stated that the scenes in motion pictures should denote action and that the films in this experiment are of such a type. The following names of some of the geography films are given as evidence on this point:

> Panama Canal, Bituminous Coal, Anthracite Coal, Iron Ore to Pig Iron, Pig Iron to Steel, Deep Sea Fishing, Wood Pulp, Wheat, Flour to Bread, Corn, Cattle, Wisconsin, Dairies, Hydro-Electric Power in the Appalachians, The Overland Route, The Oregon Trail, and The Mohawk Valley.

In general science these are some of the films:

> The Water Cycle, Water Power, A Municipal Water Supply, and Purifying City Water.

This group of films on water affords sequences upon a common subject which is a necessity of life. There is no agency through which the interrelated interests and processes of these subjects could be so accurately and effectively presented to a class of pupils as through the motion picture. One of the problems of the classroom is to co-ordinate subjects in the curriculum in such a way that pupils may get a broader knowledge of these interrelations. For instance, A Municipal Water Supply is primarily a general science film. It has direct relation, however, to the subject of health and is a fine example of a film in the field of civics. Through no agency, either still picture or text, could this correlation of interests be so explicitly shown as through the motion picture. Appended to this paper is a complete list of the films in each subject which are being developed in this experiment.

We come now to the technical aspects of the development of a film program. The first step is, of course, the preparation of a scenario. A scenario for a classroom film, as already stated, should be correlated with the curriculum. It should deal specifically with the subject matter presented through printed text and oral instruction in the classroom which it is intended to illuminate and clarify. It should call for material which will be within the intellectual grasp of children of the age and grade for whose instruction it is intended. It should deal strictly with its main thesis and should seldom go into digressions or upon excursions into other aspects of the subject. These collateral aspects should be treated in scenarios pertaining to their peculiar interests. It is not possible, nor is it necessary, to present in a film all the material bearing upon the subject to which it is related. Mere information or tabulated material should not be included. A scenario should never be padded. The basic features only, which are picturable and essential to a fundamental knowledge of the subject should be presented.

The scenes called for in the scenario should be limited, of course, to subjects, situations and processes which it is proper and suitable to present to a class of children. The scenario should be based upon sound principles of the psychology of childhood which scientific research has made available. The approach to a subject and its development in the scenario should conform to the practices of the classroom which are generally

accepted in the teaching profession. The scenario should call for a film which should always be regarded simply as an aid to the teacher in his regular daily classroom instruction.

The continuity of a scenario should be clear and without a break. The wide gaps which may be allowable in a film for mature minds are not permissible in a classroom film for the instruction of children. The continuity may sometimes be strengthened through the judicious use of titles. On the other hand, too many titles often interrupt the continuity of thought. They should not be used when the continuity may be expressed and the scenes properly interpreted without them. Titles should be short, clear and expressive. Each title should generally contain not more than a single idea. This policy of using titles should be in keeping with the sound teaching principle that a child should not be told that which he may be able to see or discover for himself. Furthermore, there is an economic aspect to this feature of a film. Titles run rapidly into footage, and the more titles are used the less footage will of course be available for scenes.

It follows from these specifications that the writer of a scenario should be a teacher of broad and deep knowledge in the field which it covers. He should be experienced in the science of education and the art of teaching. He should be a scholar and teacher of creative power. He should be endowed with imagination and the genius of an artist. He should be a master in the organization of material and should be skillful in presenting it in logical order and by effective methods.

The Eastman Kodak Company, in the selection of scenario writers, chose teachers of known interest in the field of visual education, who have had large experience in teaching the subjects on which the films are to be prepared. For instance, teachers of university training who had taught geography in public schools for ten to twenty years and are recognized by their profession as leading teachers in that subject, were chosen to aid in the preparation of geography scenarios. Two of these are teachers in large city school systems and one is a teacher of geography in the training department of a State Normal School. This group of experienced teachers sat in conference with the staff of the Eastman Kodak Company for several days, discussing the place and purpose of the film and the under-

lying principles of scenario construction. Each member of the group then prepared a general outline of a film. Each of these outlines was considered in conference by the staff and these teachers. After such conference each teacher revised his scenario and the revised product was the subject of another general conference. These processes were repeated until the Eastman staff and the scenario writers were in unanimous agreement on the scenario. These scenarios have generally passed through seven to ten revisions.

The scenarios were then edited by the editor-in-chief of the Eastman staff. They were then submitted for criticism to two of the leading psychologists and specialists in education in this country, Dr. Frank N. Freeman of the University of Chicago, and Dr. Ben D. Wood of Columbia University. These men have the esteem and confidence of the educational workers of the nation. Each of them suggested modifications which, in his judgment, would remedy defects discovered, or would otherwise improve the scenario. The scenario was then given final editorial approval and was ready for the photographic division. The same detail of procedure has been followed in preparing the general science and the health films.

In obtaining some of the scenarios for this experiment we followed a plan which has been of much interest. We suggested to the superintendent of each city in which the experiments are to be operated, that the teachers would have a greater appreciation of the value of the film in classroom instruction and a clearer understanding of its application to the subject to which it relates, if they were to write a scenario for one of the selected topics. The teachers in each of ten cities prepared a scenario under direction of the editor-in-chief of the Eastman Kodak Company. In several of the cities some of these teachers showed unusual ability in writing scenarios. They expressed themselves as being delighted with their experience and were eager to try a hand in writing another scenario.

When motion pictures have become such an established agency in classroom instruction as to receive popular recognition in the teaching institutions of the country, there will be such demand for scenarios that it will be an inducement to those teachers who are endowed with the intellectual qualities which prepare them for scenario writing, to devote their talents

to that phase of education service. When classroom films attain that status, scenarios will be brought to the producers of films on a plan somewhat similar to that which obtains between the authors and the publishers of text-books. The author prepares his manuscripts and submits them to the publisher, who either accepts or rejects them. The publishers of text-books have the privilege of selecting the product of the leading teachers and text-writers of the country. Similar privileges will come to the producers of classroom films.

The scenario is the photographer's chart. It should contain definite directions as to where scenes will be found, and complete instruction as to the type of shots he is to make. A scenario should not call for a scene unless the author knows it is in existence and specifies where it may be found. The author of the scenario should be familiar with all scenes, operations, activities, or processes for which his scenario calls. They should be described with such detail and minuteness that a photographer shall be able to interpret them. If necessary the author should even travel over territory which comes within the purview of his scenario to locate scenes which will produce the pictures contemplated.

This is not only sound practice from the viewpoint of accurate presentation of most appropriate scenes, but it is also the economical procedure to follow. If a scenario contains definite descriptions of scenes and states where they may be found, a photographer will have no excuse for not obtaining them. Someone must take the time to locate the scenes called for in a scenario. The best judge of the scenes required is the author. He is the only person who knows exactly what he visioned in writing a description of the scenes. If the photographic crew are required to locate all scenes the film will express the judgment of the photographer as he has interpreted the scenario, and may not represent the ideas which the writer of the scenario intended the film should convey.

This is no criticism of a photographer. An architect may design a building of rare lines and beauty; another architect may take the designs and plans, and in his interpretation of them make an utter failure in constructing the building contemplated by the designer. When a photographer works without these definite plans he often makes many photographs of

the same scene, and he takes numerous scenes not called for, in order to give the writer the privilege of selecting those which he regards as most appropriate. It is not at all uncommon for a photographer to bring in eight to fifteen reels of negative to get one reel of the film. This practice is expensive and results in great waste. There is loss in the time of the photographic crew in locating the scenes, and in taking unnecessary pictures; there is extravagant use of film in photographing a vast amount of unnecessary material; and there is additional waste in cutting or editing the reels to reduce the footage to the required amount. This practice adds much to the original cost of the films. The cost of films is the outstanding obstacle at present to their more general use.

One of our experiences is a good illustration of this point. We prepared a scenario on Municipal Water Supply, taking the New York City supply as an example. A photographer went into the field and brought back four thousand feet of pictures. He reported he was unable to get many of the scenes called for in the scenario. Very little of the material he brought in was usable. The author of the scenario then went to the Gilboa Dam and traced the water from the source of supply on through to New York City. He spent one week in the field. He located every scene which was necessary to make his film. After returning to the office he revised his scenario. In the revised scenario he specified the exact location of each scene, the time of day in which it was to be photographed to produce the desired proper pictorial effect, and the direction in which the scene was to be shot.

The opinion prevails very generally that it is entirely feasible to select scenes for films adapted to schoolroom needs from theatrical films, industrial films, and educational films which have been used for general entertainment purposes or mass instruction. There are, of course, many scenes in large numbers of those films which may be used to advantage in preparing films adapted to classroom instruction. We have found it wholly impractical, however, to rely upon these sources for scenes for the Eastman classroom films. It usually involves as much labor and expense, and takes as much time, to obtain scenes for a classroom film from extant material as would be involved in sending photographers into the field to take orig-

inal pictures. When films are assembled from these sources they are usually unsatisfactory. Enough scenes will be lacking so that the film fails to express the vision and the continuity of thought which the scenario represented.

The Eastman experiment has revealed, not only the desirability but the very necessity of sending photographers into the fields and plants to get fresh pictures which will represent the life, spirit and action expressed through the scenario.

There is another feature of motion picture service which illustrates how hidebound we are to tradition. The motion picture programs in the schools usually include full reels. The great majority of schools set aside an hour and show three reels. Nearly all reels cover a period of fifteen minutes. The majority of the reels in our experiment are fifteen-minute reels. Conditions in the educational world are such that it was necessary to make them of such length for this experiment.

We are, however, departing somewhat from this tradition and are making several short reels. These reels are intended to illustrate one point in a lesson. It may take one minute or three minutes to present the essential points of a lesson in a film. The time to show such film is when the lesson is under consideration.

For instance, a lesson in Geography dealing with the cocoanut industry of the Philippine Islands is given today. At the appropriate time during the recitation the teacher will show a three-minute reel dealing with that product. The next lesson may deal with the sugar industry, and the one following with the hemp industry. As these lessons are considered in recitation the proper film will be shown.

So far as possible we have planned our films on a unit basis which will readily adapt them to this type of service. I have no hesitancy in prophesying that film programs in the schools will be developed eventually on this plan. Short films may be used for several subjects in the same school. This plan would provide economical service and be of great aid in extending film use in the classroom.

In photographic field work we have found that usually the best results have been secured by sending a director and cameraman to photograph the scenes which the scenario calls for. The director has generally been a man who has worked very closely

with our editorial staff. He has acquired a definite viewpoint of the scenario as a whole and understands its spirit and purpose. In his study of the scenario he has had to visualize the entire scenario and to work out each scene step by step, so that it will fit into the general pattern.

In the field, the director specifies the outstanding features and determines the direction, distance, and even the composition of each scene, so that it will correlate with the scenes which precede and follow. He uses his initiative in taking advantage of situations as they occur on the ground. The sending of both director and cameraman adds unduly to the expense. Our experience justifies us in expressing the belief that we shall be able to train our photographers to do their own directing. For this purpose we are generally training selected men.

The motion picture is a new medium for classroom instruction and its use involves a careful study of educational values and of teaching practices. At present, impressions g ined through words bulk large in the usual classroom procedure, and the attention of teacher and pupil is devoted largely to searching out the ideas back of the words used. With motion pictures the center of interest tends to be reversed, and one of the outstanding problems is to find words with which to report clearly the observations made and inferences drawn from direct visual experience.

The lack of experience on the part of teachers in the use of motion pictures indicates that they should be supplied with carefully prepared directions and suggestions to aid them in the use of this unfamiliar tool in classroom instruction. This need for guidance is especially marked in the conduct of the Eastman experiment, in order to secure treatment in widely separated classes that will afford comparable results.

It is doubtful if anyone is able at this time to anticipate and formulate the most effective technique for the use of motion pictures in the regular program of classroom instruction. Experience alone can indicate the best procedure to follow. One point, however, seems to stand out clearly. A line of distinction should be maintained between the things actually seen in the picture and the inferences drawn from them. In a law case, witnesses are required to confine their

testimony strictly to the observed facts, it being reserved to the judge and jury to draw inferences from the evidence rendered and to pass judgment upon it. The situation is somewhat analagous in the use of motion pictures for instructional purposes, except that the pupil plays the role of witness, judge and jury. In the interest of clear thinking and sound conclusions it is incumbent upon the teacher to see to it that these functions performed by the pupils are kept distinctly separate.

It has been pointed out that a specialized technique is required for the adequate presentation of motion pictures in classroom instruction. It is not enough simply to show a picture; what the teacher does with it after showing it is vital to good instruction. This specialized technique can be mastered by the teacher through adequate training and experience.

With these considerations in mind, the Eastman Kodak Company has decided to prepare a guide to go with each film, and to hold conferences with teachers conducting the experimental classes in the various cities.

A plan to test the value of films for instructional purposes is being worked out. The Eastman Kodak Company will not formulate or conduct these tests. They will be organized and conducted under the direction of Dr. Freeman of Chicago University and Dr. Wood of Columbia University. These tests will be given to each group—the experimental group which receives instruction through the use of the film, and the control group which does not have the use of the film in its instruction. Each group, so far as possible, must be under the instruction of teachers of equal ability, and each group must cover identical areas of instruction. The tests and measurements applied will be so constructed as to reveal the quantity, quality, and speed of achievement. An initial test will be given before the film instruction starts, and a final test will be given after the completion of all film instruction. Such intermediate tests as the specialists in charge of the work deem necessary will be made. These tests will comport to methods and standards which are recognized in educational circles as modern and sound. A preliminary announcement of the results of these tests will be made near the close of the current school year. A full, detailed report will be given the public in September, 1928.

The past year has been devoted to the preparation of scenarios and the development of films. No films have yet been used in the schools in the experimental centers. The first distribution of films will be made next month, and monthly distribution will follow until all films are supplied. At the end of the current school year we shall have evidence to determine the teaching value of classroom films. We cannot, therefore, speak today on this particular question involved in the experiment.

We can, however, speak upon some of the practical and economic aspects of the problem. There are several projecting machines which are easily operated and which may be purchased at reasonable prices. These are gradually being improved and simplified. A teacher may be trained to use them in a very short space of time. Even pupils in the school may easily learn to operate them.

The use of the 16mm. stock will make a substantial reduction in the cost of films. The use of this stock clears up another problem that has been troublesome. The 16mm. films are made on safety stock. The fire hazard to the schools is not only removed, but the cost of installing booths is avoided. The circulation of films on a rental basis is not feasible nor does this method of supplying films serve the best interests of education. The school should own its own films. The cost of the equipment required for the use of classroom films and the cost of the films are within the financial ability of schools to provide.

In closing, I shall make a single prophecy, and that is, that the film is to become an effective agency in teaching institutions of the country, that film libraries adapted to instructional purposes and coordinated with courses of study will in time be established in each school, college and university, so that films adequate in number and character may be available for the daily use of the teacher as maps, charts, text-books, reference books and scientific apparatus are now available for the purposes which they serve in the classroom.

LIST OF FILM SUBJECTS

GENERAL SCIENCE

1. The Water Cycle
2. Water Power
3. A Municipal Water Supply
4. Purifying City Water
5. The Formation of Soil
6. Limestone and Marble

7. Sand and Clay
8. Compressed Air
9. Atmospheric Pressure
10. The Planting and Care of Trees—Part I
11. Reforestation
12. Fire
13. Heating and Ventilating
14. Fire Prevention
15. The Green Plant

GEOGRAPHY

1. The Hawaiian Islands
2. The Philippine Islands
3. The Panama Canal
4. Alaska
5. Bituminous Coal
6. Anthracite Coal
7. Iron Ore to Pig Iron
8. Pig Iron to Finished Product
9. The Automobile
10. The Mohawk Valley
11. New England's Deep Sea Fishing
12. Wood Pulp
13. Wheat
14. Corn Growing
15. Cattle
16. Wisconsin Dairies
17. Cotton Growing
18. The Old South
19. New Orleans
20. Hydro-Electric Power in the Southern Appalachians
21. Irrigation
22. The Pueblo Dwellers
23. The Painted Desert
24. The New South
25. Flour and Bread
26. The Union Pacific Pass
27. The Oregon Trail
28. Safety on the Sea
29. The Gateway of the Nation—3 Reels (New York City)

HEALTH

1. Posture
2. Safety
3. Respiration
4. Circulation
5. Milk

The Science of Common Things

Joseph R. Lunt,
Boston Teachers College.

XI. The Magic of Dame Nature's Mixing Bowl*

Have the following articles ready for this experiment:

Paraffin candle	Sugar, about a teaspoonful
White saucer	Pencil and paper
Two drinking glasses, dry and clean	20 capital letters C
	40 capital letters H
Two teaspoons.	15 capital letters O

Important: With scissors cut the capital letters, out of any newspaper or magazine, in small squares, of the same size. Be sure to have 20 capital C's, 40 capital H's, and 15 capital O's.

Well, well, here I am, back again, ready to give my radio friends another science lesson. Big Brother has assigned me extra time tonight,—thirty minutes. So, if I become tiresome, or cause too much static, just give your dials a twirl and tune me out. I told you during my last broadcast that tonight's lesson would be a surprise to you. And I think you will agree with me, for I intend to lead you into the fascinating byways of chemistry, and show you some of the strange magic that Dame Nature stirs up in her mixing-bowl. I hope you have all the articles ready. Let us check up. Well, I have a paraffin candle, a white saucer, two dry, clean, drinking glasses, two teaspoons, a little sugar, pencil and paper, and capital letters cut out of a newspaper. I have 20 capital C's, 40 capital H's, and 15 capital O's. The capitals are all cut in small squares of the same size.

Of course you know that Dame Nature is a wonderful cook. She holds the gold medal, the grand prize, for the number and variety of her recipes. Did you ever look on her pantry shelf? Well, take a look—and there you see 90 bottles, all carefully arranged and labeled. Each bottle contains a different substance,—black soot or carbon, life-giving oxygen, lazy nitrogen, inflammable hydrogen, yellow sulphur, iron, lead, silver, mercury, chlorine, iodine, phosphorus, zinc, copper, sodium, etc. And Dame Nature calls these 90 simple substances elements. When she wants to cook up a new dish, all she needs to do is to take two or three bottles off the pantry shelf, dip out a

* Radio Science Lesson given at Big Brother Club hour of WEEI, January 24, 1927.

little of this element and a little of that element, put them in her mixing-bowl, stir them up, cook them with fire, electricity, or sunshine; and behold, you have a brand new dish—a new substance. Suppose Dame Nature wants to make table salt, common table salt, same as you use at home on your dining-room table. Here is the way she does it. She takes two bottles off the shelf. One bottle contains a deadly poisonous yellow gas, chlorine. The second bottle contains a soft, bright metal, sodium, a metal that burns on water. She dips out a little of the deadly chlorine from one bottle, a little of the metallic sodium from the second bottle, puts them in her mixing-bowl, stirs them up, unites them, and behold you have a few sparkling white crystals of common table salt to sprinkle on your roast beef.

But listen, my friends, and I'll tell you why Dame Nature is such a wonderful cook. She is very careful. She weighs out each element with great precision, and then she takes only a small amount at a time—a very small amount. For instance, when she makes table salt she takes a minute particle of sodium and a minute particle of chlorine, mixes the two particles in her bowl, unites them, and makes a tiny speck of salt. Then she puts together several million specks and gives you a single crystal of salt. The minute particles she calls atoms, and the specks are called molecules. A single crystal of salt, therefore, contains several million molecules, and each molecule is composed of two atoms, one atom of sodium and one atom of chlorine.

But wait a moment. Let us try a few experiments. Light your paraffin candle. Take the white saucer. Hold it in the flame, right in the flame. Now, look at the bottom of the saucer. See that black stuff. That is carbon. And say—where did the carbon come from? The white paraffin of the candle. Isn't that so? Now take one of your drinking glasses. Tip it upside down. Bring the mouth of the glass down over the candle flame. Watch the inside of the glass. See! The glass becomes dim. Foggy. Rub your finger inside the glass. Ah! Water! The glass is wet. Where did the water come from? Well, look at the bottom of the candle flame. Do you see that blue region at the base of the flame? That is burning hydrogen, the lightest gas in the world. And, do you know, when this hydrogen burns it unites with oxygen of the air to form water. And right here you see Dame Nature busy in her

kitchen. She takes two minute particles, atoms of hydrogen, from that blue flame, and one minute particle, one atom of oxygen from the air around the flame. She puts the particles of hydrogen and oxygen into her mixing-bowl, stirs them up, unites them, and behold, you have a single speck, a molecule of water. Then she puts together several hundred million specks, molecules of water, and you have a whole drop of water.

And now let us try to discover how Dame Nature makes sugar in her magic mixing-bowl. You have some sugar and a teaspoon. Well, take a quarter of a teaspoonful of sugar, not over a quarter of a teaspoonful. Hold the bowl of your spoon in the candle flame. Heat the sugar. Watch it. See! It melts slowly to a liquid—and now it begins to boil. Let the sugar boil. Fast. Keep the spoon in the flame. All ready? I want you to light the sugar. Tip the spoon sideways in the flame. Let the candle flame strike the boiling sugar. See! The sugar starts to burn. Now hold the spoon away from the candle flame. Watch the sugar burn. All ready? Take a dry, clean, drinking glass. Hold it upside down. Bring the mouth of the glass down over the burning sugar. Watch the inside of the glass. See! The inside of the glass becomes dim, misty. Moisture. Water. Rub your finger inside the glass. Wet, isn't it? Water—from the burning sugar—and tell me what is water made of? Hydrogen and oxygen. Isn't that so? And tell me again. Where did the hydrogen and oxygen come from? Right. From the sugar. Now, let the sugar continue to burn. See the black stuff in the spoon? That black stuff is carbon, Dame Nature's most wonderful element.

Therefore, you see, you have taken sugar apart, separated it into its elements. And what have you discovered? What is sugar made of? Three elements—just three elements—carbon, hydrogen and oxygen. Isn't that true? Sugar is composed of black soot or carbon, the inflammable gas hydrogen, and the life-giving oxygen. So you see, when Dame Nature wants to make cane sugar, she takes three bottles off her pantry shelf. One bottle contains black soot, carbon, the second bottle contains hydrogen, and the third bottle contains the invisible gas, oxygen. She takes 12 minute particles of carbon from the first bottle, 22 minute particles of hydrogen from the second bottle, and 11 minute particles of oxygen from the third

bottle. She puts all these particles, atoms, into her mixing bowl, stirs them up, cooks them with sunshine, and behold, you have a tiny speck, a molecule of sweet sugar.

I have told you the secret of Dame Nature's magic, but I want to prove to you that she is the most marvelous cook in the world. I asked you to cut a few capital letters in small squares of the same size, from any paper or magazine. I hope you did so. You should have 20 capital C's, 40 capital H's, and 15 capital O's. All right. Make three piles of these letters. Put all the C's into one pile, the H's into a second pile and all the O's into the third pile. Let the three piles of letters represent three bottles of elements on Dame Nature's pantry shelf. Let the pile of capital C's represent her bottle of black soot or carbon. Let the second pile of capital H's represent her bottle of gaseous hydrogen. Let the third pile of capital O's represent her bottle of invisible oxygen. And we will let each capital letter represent a single minute particle or atom of the element.

All ready? Here is your first real cooking lesson. You are about to learn the secret of Dame Nature's magic. To discover all the wonderful dishes she cooks up with only three different materials with which to work, carbon, hydrogen and oxygen. Well, let us start. Remember now, each capital letter represents a single minute particle or atom, and the three piles represent bottles of carbon, hydrogen or oxygen borrowed from Dame Nature's pantry shelf. Take one particle of carbon, a capital C. Lay it on the table in front of you. Now take one particle of oxygen, a capital O. Place the capital O right beside the capital C, on the table. What have you? CO? Right. Carbon monoxide, the deadly gas that comes from your automobile exhaust and coal range—the gas that kills so many victims each year. All right. Take another particle of oxygen, a capital O. Place it beside the CO. You have COO, carbon dioxide, the harmless gas that you exhale with every breath, that you drink with every bottle of tonic, the gas that makes the little holes in the bread you eat for lunch. Put the letters back into each pile again. Now take two particles of carbon and two particles of hydrogen. Lay the particles side by side. You have CCHH, C_2H_2, a tiny speck of another wonderful gas, acetylene, the gas that burns with a flame so hot that it cuts through iron and steel

like so much cheese. Try again. Take six particles of carbon and fourteen of hydrogen. Lay them side by side. See, you have CCCCCCHHHHHHHHHHHHHH, 6 C's and 14 H's. C_6H_{14}, a single speck of gasoline, the liquid fuel that you put into the tank of your automobile, to make it go. Yes, sir, that is the way Dame Nature makes gasoline. Now, just add four particles of soot or carbon, and two particles of hydrogen to your gasoline. You get $C_{10}H_{16}$, rubber,—the rubber in your pencil eraser or overshoes. All right. Take away 8 particles of hydrogen from rubber. What have you? Ten C's and eight H's, $C_{10}H_8$, naphthalene, moth balls,—the funny-smelling moth balls your mother puts in her cedar chest. Now add 2 particles of carbon and 2 particles of hydrogen to moth balls. Ah! You have a beautiful dye, turkey-red—the same dye that makes your red dress or necktie so vivid. Try again. Take 7 particles of carbon and 8 particles of hydrogen, put them in your mixing-bowl, unite them. What have you? Toluene, C_7H_8, the basis of the terrible explosive that killed so many brave men during the World War. T.N.T. Say, here is a funny one. Just add 8 particles of hydrogen to your toluene and you have naphtha, the fluid that cleanses your suit and takes out the spots when you send it to the tailor. Add 4 particles of carbon and 8 particles of hydrogen to naphtha and you get kerosene. Add 8 particles of black soot and 16 particles of hydrogen to kerosene, and you get vaseline. Add one particle of carbon and 2 particles of hydrogen to vaseline, and you have a candle, a paraffin candle like the one on your table. And so on. But wait. My story is not finished yet. I have shown you a few of the wonderful dishes Dame Nature cooks up with only two elements, carbon and hydrogen. She can make all these dishes from only two things. I'll bet that's better than you can do. I'll bet you couldn't cook up so many dishes, if you had only two kinds of material with which to work. And now, let us add the bottle of oxygen to our other materials. Let us watch Dame Nature work with three elements,—carbon, hydrogen and oxygen.

Suppose you take 1 particle of carbon, 4 particles of hydrogen, and 1 particle of oxygen. See, you have wood alcohol, CH_4O, the deadly wood alcohol the bootlegger sells to his unsuspecting victims. But listen. Add one particle of soot or carbon, and one particle of oxygen to the poisonous wood alco-

hol. Ah! You have changed wood alcohol to vinegar, harmless sour vinegar for your salad dressing or pickles.

Try this recipe for your dinner menu. Subtract 1 particle of carbon, 2 particles of hydrogen, and 1 particle of oxygen from the vinegar. See? You now have formaldehyde, CH_2O —composed of 1 particle of carbon, 2 of hydrogen, and 1 of oxygen—formaldehyde, the stuff you use to disinfect the bedroom after the patient has recovered from diphtheria or measles.

Add 3 particles of carbon and 8 particles of hydrogen to the germ-killing formaldehyde. Look at that stuff. Smell it. $C_4H_{10}O$. Do you recognize it? That stuff is ether, the ether that puts you to sleep when you inhale it. Suppose you want a few drops of carbolic acid to rub on a cut finger or sore toe. Shall we make some? All right. Just add 2 particles of carbon and take away 4 particles of hydrogen from ether. There you have it—a few drops of the funny-smelling carbolic acid. Talk about Dame Nature's magic and her ability as a cook! Just add 2 particles of carbon and 2 particles of hydrogen to your funny-smelling carbolic acid, and now, take a smell of that stuff. Recognize it? Vanilla extract, to flavor your puddings or sponge-cake.

Shall we continue? Take away 4 particles of carbon and add 6 particles of oxygen to vanilla extract. Taste it. Good? Lemon juice. That is real lemon juice—$C_4H_8O_7$.

Take 1 particle of carbon, 2 particles of hydrogen, and 4 particles of oxygen away from lemon juice and you get sour milk—$C_3H_6O_3$.

But perhaps you are not fond of sour milk. All right. Add 3 particles of carbon, 6 particles of hydrogen and 3 particles of oxygen to your glass of sour milk—and you have a glass of honey, real honey. What do you say? Shall we eat the honey? Ah! too late! The honey is gone. Take 2 particles of hydrogen and 1 particle of oxygen away from the honey. See! You have cellulose,—a sheet of paper. The glass of honey has been changed into several sheets of nice white writing paper. Yes, sir. Dame Nature is certainly a great cook. Good night.

Dry-Ice[1]

Howard W. Geisler

The use of solid carbonic acid, or carbon dioxide gas, as a refrigerant has now reached the commercial stage, and the new industry created by its manufacture is making very remarkable strides. This Dry-Ice, as it is called, evaporates into a gas instead of melting into a liquid. It looks like a mass of dazzling white marble. Its temperature is about 109° below zero, or 141° colder than water ice.

This pyramid of Dry Ice attracted much attention at the recent Electrical Exposition

Dry-Ice is the result of the commercial application of a process long known to physicist and chemist. Carbon dioxide, the gas used to carbonate soda water, liquifies under a pressure of about 1,100 pounds to the square inch. A tank of this liquid is usually a part of the equipment of most school laboratories. It is always one of the sports of the professor to open the tank allowing the gas to escape, catching in a cloth bag the white "snow" which forms, for the delectation of his pupils.

It is this snow, manufactured on a commercial scale and compressed into cakes of any desired size that is now known as Dry-Ice.

Dry-Ice was born under wet auspices, so the story goes. In the eighteen-sixties a British army officer stationed in India wanted something to carbonate and cool his Scotch and soda. He knew that the solid carbonic gas would do this, and he worked out a method of conveniently producing his drinks. He took out a patent, but there was no commercial development, probably because of its costliness.

By the laboratory method, and probably that used by the British army officer, only ten or fifteen per cent of the carbonic acid gas would condense into snow, while the improved

1 From Edison Monthly, Nov. 1927, by courtesy of the New York Edison Company.

commercial method obtains thirty per cent or more in condensation.

About three years ago the Dry-Ice Corporation of 50 East

Photograph by The New York Edison Company
The plant of the Dry-Ice Corporation at Yonkers, N. Y.

Forty-second Street, New York City, began the manufacture of this ice at a plant in Maspeth, Long Island, putting out about seven hundred pounds daily. Today the company has

Photograph by The New York Edison Company
The compressors at the plant of the Dry-Ice Corporation

two other plants, one at Philadelphia, and one at Yonkers. Thirty thousand pounds a day are now being produced at the latter plant, and it is expected the production will be increased very shortly to its full capacity of forty thousand pounds.

The process of production is a complicated one in which electricity plays an important part. Briefly the liquid carbon dioxide is forced through a number of very small apertures, to facilitate the rapidity of evaporation. This spray is played under pressure into specially designed tanks which catch and hold the snow. The snow is automatically scraped from these

Packing Dry-Ice in a shipment of ice cream

tanks, and then under three thousand pounds pressure it is molded into firm, white blocks.

Electricity is used to create the pressure to spray the liquid through the openings, and for the motors that operate the hydraulic presses which force the snow into molds. There are also electric conveyors which carry the blocks of ice to the shipping room. The blocks are so hard that they are best cut up by electric power saws, or where that is not practicable by hand saws.

Dry-Ice finds its greatest usefulness at present in commercial fields. A fish company uses it for icing shipments of fresh seafood to the West. In shipments to Detroit that would re-

quire 17,000 pounds of water ice, with two or more stops on the way for re-icing, only 1,200 pounds of Dry-Ice are required, leaving the space that would be occupied with ice free for fish. Dry-Ice being dry, there is no deterioration to rolling stock or product being shipped as there is no moisture and no brine. The carbonic acid gas released by the evaporation of the Dry-Ice drives out the oxygen and thus prevents decay.

Another example is the shipment without excessive freight charges of ice cream to Cuba. Packed in containers with Dry-Ice the cream arrives after five days in such perfect condition, fresh, firm and dry, that two New York Companies have devel-

Another ice cream shipment protected by Dry-Ice

oped a thriving trade there in this American delectable. The ice itself can be easily sent by express or even parcel post to summer camps or farms. Its reduction by evaporation is about ten per cent in each twenty-four hours when enclosed in an approved storage box. A forty-pound cake, for instance, in such a box will last from one to two weeks. Balsol wood, a cork-like substance, has been found to be best suited for the shipment and transportation of Dry-Ice, because of its light weight.

For local delivery of ice cream two paper cartons suffice, with a very small piece of Dry-Ice no larger than the palm

of your hand on top or below the inner container. Ice cream will keep perfectly on the hottest days, by this method. This makes it possible for the product to be handled by grocers and delicatessen dealers, and to be delivered with the usual order of potatoes, flour and eggs. Light-weight packages of butter, cheese, eggs, may now be mailed or expressed by using Dry-Ice as a refrigerant.

A delicate pastry being prepared for shipment. Dry-Ice and the band-saw for cutting it are seen in the background

Because of the preservative property of the escaping carbon dioxide gas, as well as the refrigerant properties of Dry-Ice it is doubly valuable in refrigerators or refrigerator cars. Each pound of snow yields about eight cubic feet of gas, which is allowed to fill the refrigerated space and to overflow from vents situated as near the top of a refrigerator as practicable. This ventilation system removes odors and in addition, the heat leaking through the wall is absorbed and vented along with the gas overflow. This tends toward a much lower temperature and more wholesome atmosphere in the ice box.

There are a number of other ways of using Dry-Ice in industry. In oil refining, it facilitates the removal of paraffin, particularly for low cold test oils. Public utilites find it useful for testing electric cables at low temperatures; in building and construction it is valuable in freezing quicksands in tunnels and foundations, and in testing insulating qualities of building materials; in the varnish industry for testing the product; in candy making for quickening cooling and producing speedier crystallization; in wool, fur and grain storage for protection against vermin, and in the chemical industry for rapid

cooling and condensing of low boiling point distillates. It is also used as a local anesthetic for surgery and dentistry.

Dry-Ice is another instance of the use of a by-product of commerce. The Syrup Products Company plant at Yonkers, in whose building the Dry-Ice Corporation plant is housed, produces carbon dioxide gas as a by-product in the distillation of alcohol from molasses. Previously this gas was put in drums and sold to beverage makers and others. Now it is used in making Dry-Ice, and is the only raw material used.

The New Books

Modern Experimental Chemistry—H. R. Smith and H. M. Mess—204 pages—85 experiments—loose-leaf form—Henry Holt and Company.

This is really more than a laboratory manual, for a page of explanation or introduction is given leading up to the experiment itself. There is a good variety of experiments and more than can be done in the usual high school course.

Chemistry Calculation—E. L. Dinsmore—182 pages—Globe Book Company.

A very good book for problem drill, as it gives the theory and principles upon which the problem work is based. Questions for review involving mathematical solutions are also included.

Digest of Elementary Chemistry—Martin Mendel—234 pages—22 illustrations—paper covers—Globe Book Company.

A very concise manual of the important facts, principles and processes of elementary chemistry. It will serve well as a guide for review in preparation for College Board Examinations. Many trial test questions are introduced.

The Harvard Tests: High School Chemistry—H. L. Gerry—Forms A and B—48 cents each—Ginn and Company.

Each test comprises twenty-five test questions, mainly of the selection and completion type. Each set contains thirty copies of the test held together in paper covers. The covers describe the test, give directions to the examiners, and have a correction key. A blank is provided for the class record. These tests should prove helpful to the busy teacher.

First Principles of Chemistry—F. W. Doolson and A. J. Berry—339 pages—43 drawings—6 shillings—The Macmillan Company.

The purpose of this book is to minimize the taking of notes during elementary chemistry lectures by university students. It is planned as an aid for study in connection with lectures and laboratory work in general chemistry. It is not loaded down with theory. The Periodic Law is omitted as unsuited to elementry courses, and the Law of Multiple Proportion is omitted as obsolete. There is good treatment of coloids and ionization.

Secondary School Curricula—Willis L. Uhl—582 pages—The Macmillan Company.

The scope of this book is indicated by the titles of the different sections: (1) The origin and development of the secondary school curriculum, (2) Constructive courses of secondary school curricula as a basis for progress, (3) Educational objectives and curricula values, (4) Pupils and curricula, (5) Curricula and local conditions, (6) Present-day curricula.

Nature Study and Science—Gilbert N. Trafton—367 pages—202 illustrations—$1.20—The Macmillan Company.

This book appears to be a pioneer in science texts for the lower grades as it has been definitely prepared for the fourth, fifth, and sixth grades. The material is separated into seasonal studies. In the fall, it takes up garden and wild plants, insects, aquariums, rocks and minerals, playground sports, and stars. The winter part takes up winter birds, sports, and amusements, sky studies, and pets. In the spring, the studies are about weather, windy-day toys, gardens, birds, flowers, bees, and water sports.

The preparation of a book like this is a move in the right direction, and the work has been well done.

Plant Respiration—S. Kostycher—Translated by Charles J. Lyon—163 pages—6 cuts—P. Blakiston's Son and Company.

This book aims to give the outstanding features of the science of plant respiration as far as known at the present day. It also describes methods useful in guiding one in experimental study of plant respiration. Contents: Oxygen respiration; Anerobic respiration; Chemical processes in plant respiration; Respiration at expense of mineral substances.

Introduction to World Geography—P. A. Knowlton—298 pages—262 illustrations—Colored maps and pictures—$1.32—The Macmillan Co.

This book is intended as an introductory text for the Fourth Grade. "Man's behavior is studied under various climatic and physiographic conditions in environments definitely located and oriented with respect to the pupil." An excellent text, attractive in appearance, simple but comprehensive, it leads the child from home conditions to those in distant lands.

Introductory Chemistry—Neil E. Gordon—600 pages—136 illustrations—$2.20—World Book Company.

Introductory Chemistry contains the new facts and principles now approved by scientists. The book is divided into two parts, the first part containing those fundamentals of the science recommended in the revised report of the committee on chemical education of the American Chemical Society. This part also meets the requirements of the College Entrance Board for a year's high school credit. Part II contains additional optional topics from which selection may be made to supplement the course in accordance with the class needs. The author has blended experiments and text, following the true scientific method by which the student discovers for himself, rather than has things told to him.

The Normal Diet—W. D. Sansum, M.D.—136 pages—$1.50—C. V. Mosby Co., St. Louis.

The purpose of this book is to fill a need of information regarding diet errors, and of the fundamental principles underlying the selection of a normal diet. The book will find service in the hands of both physicians and patients.

Getting Well and Staying Well—John Potts, M.D.—223 pages—$2.00—C. V. Mosby Company, St. Louis.

This is a book for the lay reader and has a special message to the patient, nurse and doctor, on the subject of tuberculosis. Much good will come from spreading the information and acting upon the suggestions and advice given.

Laboratory Experiments in Practical Chemistry—N. H. Black—188 pages—85 experiments—illustrated—The Macmillan Company.

This is a bound volume of experiments in elementary chemistry. It includes the standard experiments and has in addition some experiments on the practical applications of chemistry. Important tables are given in the appendix.

Laboratory Manual of General Inorganic Chemistry—M. C. Sneed and R. E. Kirk—181 pages—245 experiments—illustrated—$1.20—Ginn and Company.

Here we have an abundance of experiments from which to select to make up our course. The manual was written particularly to go with the author's "General Inorganic Chemistry," and follows the order of chapters in that text. There are many exercises and problems based upon the experimental work.

New Type Questions in Chemistry—Charles G. Cook—104 pages—$.80—Globe Book Company.

The variety of types of questions which are found in this little book are: essay form; true-false; completion; evidence; wrong statements to correct; home tests in which research is required to find the answer. There is much in favor of giving a variety of types of tests. Elementary chemistry is covered in these tests and the busy teacher will find them a great convenience.

Our Neighbors in South America—Walter Lefferts—306 pages—112 illustrations—$1.20—J. B. Lippincott.

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Laboratory Layouts for High School Sciences.—A. C. Monahan—31 pages—13 illustrations—10c—United States Printing Office, Washington, D. C.

You will find in this pamphlet a very good description of the essentials of the laboratories for the various High Schools. There are photographs and diagrams of laboratories from these schools.

Illustrative Material.—Fay Griffith and Mamie O. Lott—35 pages—paper covers—50c—Published by authors, Normal School, Terre Haute, Indiana.

This is a very useful pamphlet, it gives lists of bulletins, booklets, exhibits, and pictures. Prices are given when the material is not furnished free. "How to Order" and "How to Care for Materials" are topics well covered.

A Laboratory Course in General Zoology—H. S. Pratt—244 pages—$1.72—Ginn & Co.

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Science Articles in Current Periodicals

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Learning to Use Our Wings. Sci. Am., p. 539, Dec. 1927.
All in Metal Air Liners. Sci. and Inv., 15:406, Sept. 1927.
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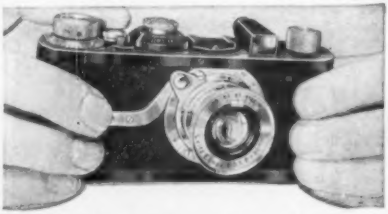

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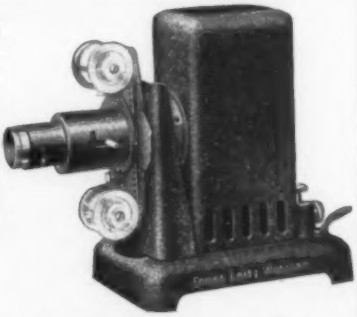

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General Science Quarterly. Salem, Mass. Quarterly. 40c a copy, $1.50 a year. The only journal published devoted alone to science in the elementary and secondary schools. It tells what schools are doing in science, gives lesson plans, demonstrations, and an extensive bibliography of usable articles in current periodicals.

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Journal of Chemical Education. Kodak Park, Rochester, N. Y. Monthly. $2.00 a year. Promotes chemical education; primarily a journal for the chemistry teacher. Digests of activities of chemical associations.

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